



ENERGY USE ENGINEERING DEPARTMENT

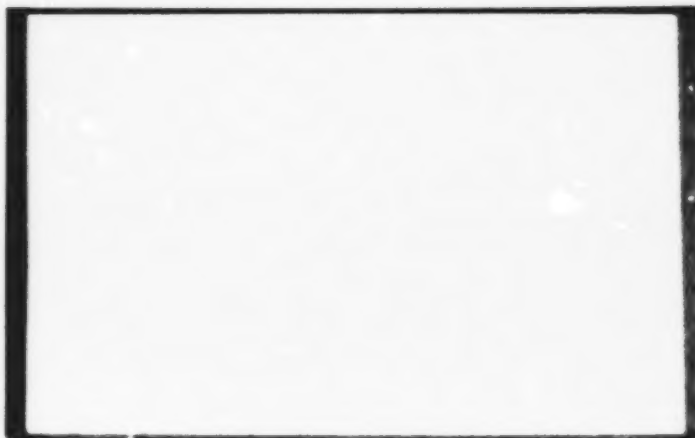
PROJECT 8308

THE IMPACT OF INDUSTRIAL AUTOMATION,
NEW PROCESSES & ROBOT TECHNOLOGY
ON B. C. HYDRO'S ELECTRICAL REQUIREMENTS
1985 - 2005

ENERGY CONSERVATION DIVISION

B.C. HYDRO AND POWER AUTHORITY





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The Energy Use Engineering Department provides engineering, technical and marketing impact advice on energy use with emphasis on energy management, prudent energy usage, efficient applications and energy conservation.

The service is provided by a team of four sections supervised as follows:

- | | |
|---|------------------------------------|
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| *ELECTRICAL & LIGHTING (including associated wiring, electronics, and codes) | R.F. Hughes, P.Eng. (663-3280) |
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Please don't hesitate to contact us should you require additional information or should you have any suggestions on how we can better provide the service required.

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PROJECT 8308
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SYNOPSIS:

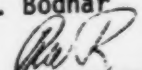
New Industrial Processes and Robot Technology are not expected to have a significant effect on B. C. Hydro's electrical requirements in the period under consideration for the current industrial base. However, the growth trends of new industries must be analysed individually before more wide ranging projections can be made.

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ENERGY USE ENGINEERING DEPARTMENT
PROJECT SUMMARY

PROJECT No. 8308

PRIORITY 1

TITLE: THE IMPACT OF INDUSTRIAL AUTOMATION, NEW PROCESSES & ROBOT TECHNOLOGY
ON B.C. HYDRO'S ELECTRICAL REQUIREMENTS
1985 - 2005

INITIATED/REQUESTED BY: R.F. HughesASSIGNED TO: G.D. HenriquesASSIGNED BY: M.W. BodnarDATE ASSIGNED: January 1983DATE REQUIRED: February 1983ESTIMATED COMPLETION: February 1983COMPLETED: February 1983

OBJECTIVES AND NOTES:

New Industrial Processes and Robot Technology are not expected to have a significant effect on B.C. Hydro's electrical requirements in the period under consideration for the current industrial base. However, the growth trends of new industries must be analysed individually before more wide ranging projections can be made.

The information contained in this project report is to contribute towards project report 8130 for Roy Hughes.

COPIES TO: DEPARTMENT MANAGER (THEN RECORD FILE), BLUE FILE, SUPERVISOR, (M.W. Bodnar)
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PLEASE ADVISE AS SOON AS POSSIBLE IF CHANGES ARE REQUIRED ABOVE



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1.0 INTRODUCTION

The techniques of data processing and planning are common to all corporations, irrespective of sector or function, even though there may be detailed differences in the balance of applications. There would appear to be no similar commonality in the uses of computing to control industrial processes, and as a consequence the rate of development of this type of use has been much slower.

The major advancements in process automation and robot technology have occurred in recent years because of the proliferation of micro chips. This trend will eventually result in large productivity improvements in industry and increases in production capacity.

Automation equipment is now economically viable for a wide range of industrial processes and operations and is being introduced into a variety of new environments. Usually computer control has been adopted to overcome some specific problem. For example, in the catalytic cracking of crude, the problem is the variation in the raw materials; in heterogenous phase catalysed petrochemical reaction, the time constants are too short for effective human intervention; in the production of cement or the continuous casting of steel, high economic return can only be obtained if the plant is very efficient.

In the case of batch production, the economic incentive for computer control has been much less. Where computer control has been adopted, it is often for other reasons, for example to obtain the necessary precision in aerospace part machining, or to reduce risk to human life in hazardous environments like nuclear engineering.

Numerically controlled (NC) machine tools have not been widely adopted. In part this has been due to the large increase in productivity possible with NC tools, which can lead to an imbalance in scheduling across a machine shop; and in part it has been due to the high cost of NC tools, which cannot be justified given the small volume and jobbing nature of many small engineering firms.

The objective of this report is to examine the potential applications of automation and robotization and new process applications, and to assess their impact on B. C. Hydro's electrical requirements for the period 1985 to 2005.

Automation and robotization in the long-term is expected to reduce the energy requirements for most production processes because of the more rapid production rates and optimized manufacturing methods. This adds up to improved productivity. The impact of these changes on our energy demands will vary from industry to industry and will require individual examination. The effects of the world market for the products we produce now, and those which we can anticipate producing in the next 20 years, will also have to be considered in this analysis.

2.0 INDUSTRIAL ELECTRICAL CONSUMPTION

The industrial electrical energy sales in B. C. Hydro's service area in 1982 amounted to 18,513 GW.h (million kW.h) and represented 68% of total sales. Appendix A contains the Energy Consumption Distribution by Industry Classification derived from the Industrial Consumption Analysis Program (ICA). In this classification system, "Industrial" signifies all non-residential use categories, i.e. industrial process, agricultural, commercial and institutional.

The major industrial use categories representing 55% of the total industrial energy consumption are:

- 1) Paper and Allied Products;
2. Wood;
- 3) Mines; and,
- 4) Chemical and Chemical Products.

Figure 1 shown below indicates the percentage breakdown of the 18,513 GW.h of industrial and commercial energy sales in B. C. for 1982.

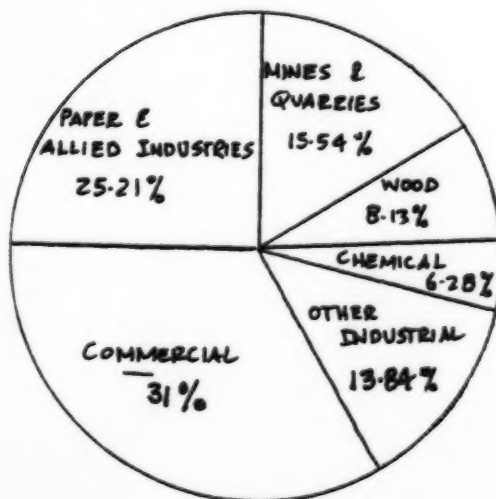


Figure 1

3.0 PAPER AND ALLIED INDUSTRIES

Paper and allied industries purchased 4666 GW.h of electricity from B. C. Hydro in 1982. This represented 25.21% of the Industrial Energy Sales.

Several different processes are currently being used in the manufacture of mechanical pulp each requiring different quantities of electricity for production. The current average unit consumptions are as follows:

Type	kW.h/tonne
Stone Groundwood	1975
Chemi thermal mechanical pulp (CTMP)	1700
Thermal mechanical pulp (TMP)	2200
Refiner mechanical pulp (RMP)	2400

It is forecast⁽¹⁾ that the production of stone groundwood will decrease annually to zero by the year 2000. RMP will probably remain fairly stable for the same period, while TMP & CTMP will rise rapidly in production to the end of the century. Bearing the above figures in mind and being able to forecast the future production levels of mechanical pulp will enable us to forecast future electrical requirements for this industry.

Developments in the pulp and paper industry for which the technology is available but which have not been adopted in B. C. will be examined.

(a) Displacement Bleaching

Displacement bleaching involves the use of one tower to accomplish four or five stages of bleaching which would have required one separate tower per stage previously. The net saving achievable by the use of displacement bleaching is estimated at 35 kW.h/ADT.*

Displacement bleaching will likely be incorporated into new mills. It may also be applied in some existing pulp mills where bleach plants have deteriorated beyond the point of economical repair.

(b) Recycling Newsprint

The recycling of newsprint is only expected to have a marginal percentage of the newsprint production in B. C. in the next two decades. Newsprint produced by recycling results in a marginal decrease in energy per tonne. Therefore although this production method will decrease energy use, the net effect on electrical demand will be negligible.

* ADT Air Dried Tonne.

4.0 WOOD INDUSTRY

The main energy source used in the wood industry is electrical. The energy drives electric motors which convey, cut, sort and plane lumber. Changes in production techniques are likely to be of a control nature which could fine tune operations for optimum efficiency. These changes are expected to result in reduced electrical consumption per unit of product produced and were taken into account in the B. C. Hydro Electrical Motor Energy Conservation Impact Report #7854.

In 1982 the wood industry accounted for 1506 GW.h or 8.13% of the Industrial Electrical Energy purchased from B. C. Hydro.

5.0 CHEMICAL INDUSTRY

The chemical and chemical product industries in B. C. include the manufacture of fertilizers, resins, plastics, paints, soap, industrial chemicals (caustic soda and chlorine), and pharmaceuticals.

The chemical and chemical products industries purchased 1663 GW.h of electricity from B. C. Hydro in 1982. This represents 6.28% of the industrial electrical sales.

The industrial chemicals which account for about half of the value of the chemical industry and use about 94% of the energy of this industry are nearly all used in the pulp and paper industry. Fertilizer manufacture, the other large chemical industry, is controlled mainly by Cominco at Trail and Kimberley.

Chlorine and sodium hydroxide are produced by the electrolysis of brine. The main energy demands are: electric power for electrolysis and motive power for refrigerating and compressing the gas.

The fertilizer base requiring most energy for its manufacture is ammonia. Natural gas is used as a raw material for ammonia production. Process heat in the form of steam is used to convert the natural gas via a series of processes into liquefied ammonia. The fertilizer ammonium nitrate is then produced by chemical reaction between the ammonia and nitric acid.

The other fertilizers - potassium chloride and superphosphates - require very little energy for their production and are not considered here.

Little change in energy requirements are anticipated for these processes because of new developments. Electrical energy reduction in some of these will result because of efficiency improvements and would have been covered in the E. C. Impact Studies.

6.0 METAL MINING

Metal mining in B. C. is dominated by large, open-pit copper/molybdenum types of operation. In 1982 B. C. Hydro sales for mines and quarries amounted to 2877 GW.h or 15.54% of the industrial electrical sales.

Electricity is the major form of energy used in mines. It is used predominantly for the milling process to crush and grind the ore prior to flotation. Other significant uses of electricity are: electric shovels in pits, hoisting ore in underground mines, conveying ore, electrically operated drills, air circulation in underground mines and for lighting and heating.

Technological change besides that which has been estimated for the EC Impact Studies is not expected to result in any drastic change to consumption.

Studies for new mines would have to be conducted for individual operations.

7.0 COAL MINING

B. C. Hydro has estimated that the average amount of electricity consumed for coal mining is 32 kW.h/tonne in 1980. Because of higher stripping ratios and an increase in the use of electrical conveyor systems, the average electricity consumption for coal mining by 1990 is expected to reach 40 kW.h/tonne. For the period 1990 to 2005 only marginal increases in the unit electricity energy use is anticipated.

8.0 CEMENT INDUSTRY

This industry represents about 62% of the total energy used by the non-metallic mineral products group which accounted for 266 GW.h/yr in 1982, (1.44% of total industrial electricity sales by B. C. Hydro).

There are two processes used in the manufacture of cement; the wet process which uses 122 kW.h/ton, and the dry process which uses 135 kW.h/ton. The wet process is commonly used today, but the dry process, although it uses 10% more electricity, can potentially save 40% of the natural gas use if pre-heat is incorporated. New cement plants that are built are expected to use the dry process.

9.0 SUMMARY

The reduction in cost of computing equipment does little to remove the barriers to the adoption of current forms of computer control. The computer represents only a small part of the required investment, which is dominated by instrumentation and systems development costs.

What it does do is to open a new approach to industrial automation based on the piecemeal improvement of plant using intelligent instrumentation or local microcomputer control to improve some sub-system. A wide variety of "smart" instrumentation products incorporating microcomputers is already becoming available, and although most of these instruments are currently oriented to human operation, it is to be expected that an increasing proportion will be designed for autonomous operation with data-communication capability. The addition of a microcomputer enables a variety of improvements to be made to an instrument.

Piecemeal automation may be expected to stimulate the application of computer control to existing plant. This is particularly relevant to public utilities where the distinction between continuous processes and production scheduling is blurred, since demand varies continuously but supply is controlled incrementally. Because of the extent of investment in established technology, and the high cost of providing reserve capacity to cater for peak load, it is probable that the current trend to providing more real time responsiveness on the supply side, and the balancing of supply resource allocation by computer will be accompanied by the use of marginal pricing mechanisms to produce more uniform demand and therefore more overall optimal use of resources. In this way, it should be possible to stretch the existing investment to support a much higher level of average activity. These concepts are relevant to utilities like electricity, telecommunications and road networks and could lead to a reduced demand by these utilities for capital investment while the latent capacity is exploited with the aid of microelectronics.

The concept of automation is usually associated with automatic manipulation and assembly techniques. The replacement of the human in such situations requires either a high degree of robotic sophistication, or radical re-design of products and techniques. The development of effective robotic devices is regarded as a hard robotic problem while radical product re-design is not readily assimilated. For these reasons, the introduction of highly automated assembly techniques is expected to be relatively slow. Again, the piecemeal approach is likely to apply, with certain limited tasks being taken over by computer control, thereby reducing the need for human intervention without eliminating it altogether. Robotic systems like car body paint sprayers, based on programmed learning by following human actions, will decline in cost and so become more widely used. The development of adaptive operation in such devices, as contrasted to the current mode of operation which is purely repetitive, is unlikely to be feasible at more than a trivial level until the long term.

10.0 CONCLUSIONS

The progress towards automation has been much slower than expected. There have been various reasons for this:

- the theoretical difficulties associated with developing total control systems and robotic devices;
- the disparity between applications, which makes generalized techniques inappropriate;
- the cost barrier, which has meant that computer control was only applicable to large systems and therefore had to tackle inherently difficult problems and achieve larger economies;
- the feared, or actual, social consequences of introduction of automation, associated with other radical changes into areas where the workforce was often well organized.

The developing technology does not solve these problems. However, by reducing the cost of computer control, it does open the way to piecemeal automation and bring down the level of improvement necessary to make automation worthwhile. Gradual automation has the potential to be more acceptable to the workforce, since it does not cause the same upsets in job content nor dysfunctions in employment. Even so, the fear of automation is likely to remain, and likely to act as a powerful brake on its introduction.

In the future it is expected that progress towards automation will continue to be slow, even though the development in micro-electronics makes it more attractive. Progress is also likely to be very uneven between industries, because of the specialized nature of much automation, and the dependence of many of the barriers on the type of industry concerned. It is to be expected that the direct employment consequences will be small, although the indirect consequences (as improved efficiency reduces the need for new investment) could be larger. Even so, less than 20% are employed in actual manufacturing operations, so that the overall consequences for employment are not very great.

The principal applications for robots occur in the electronics' industry, automobile production, plastics and metal working. These industries are in their infancy in British Columbia and their electricity requirements are not expected to have any significant impact in the foreseeable future.

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B. C. HYDRO
1982 ANNUAL ELECTRIC INDUSTRIAL
CONSUMPTION ANALYSIS SUMMARY

Industry classification	Energy GW.h	Percent of Industrial Energy
INDUSTRIAL		
Agriculture	11.75	.06
Forestry	28.42	.15
Fishing & Trapping	17.39	.09
Mines & Quarries	2,877.01	15.54
Food & Beverage	332.46	1.80
Rubber & Plastics	34.02	.18
Leather	.45	neg
Textile	4.09	.02
Knitting Mills	.09	neg
Wood	1,506.00	8.13
Furniture & Fixtures	8.51	.05
Paper and allied ind.	4,666.63	25.21
Printing & Publishing	47.35	.26
Primary Metals	129.75	.70
Metal Fabricating	138.77	.75
Machinery	47.50	.26
Transportation equipment	57.67	.31
Electrical Products	30.64	.17
Non-metallic Mineral Products	266.08	1.44
Petroleum & Coal	341.69	1.85
Chemical & Chemical Products	1,163.47	6.28
Miscellaneous Mfg.	8.83	.05
General contractors	137.32	.74
Special trade contractors	27.68	.15
Transportation	351.87	1.90
Storage	174.03	.94
Communication	169.62	.92
Electric Power, Gas & Water Util	205.15	1.11
COMMERCIAL		
Wholesale trade	306.37	1.65
Retail trade	979.30	5.29
Finance	125.52	.68
Insurance Carriers	12.51	.07
Real Estate & Insurance Agents	330.09	1.78
Apartment Buildings	162.42	.88
Office Buildings	380.51	2.06
Shopping Centres	95.75	.52
Trailer Parks	8.94	.05
Education	648.50	3.50
Health & Welfare	288.42	1.56
Religious Organizations	32.48	.18
Amusement & Recreation Serv	237.40	1.28
Services to Business & Mgmt	67.74	.37
Personal Services	31.46	.17
Accommodation & Food Services	715.03	3.86 *
Miscellaneous Services	78.60	.42
Public Administartion	419.94	2.27
Unspecified	786.40	4.25
Total	18,512.95	100%